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Method and Apparatus for Measuring the Profile of Small Repeating Lines

Abstract

A method for nondestructively determining the line profile or topographical cross-section of repeating lines on a substrate is provided, including line thickness, line width, and the shape of the line edge. A substrate having a repeating structure, such as a grating, is illuminated with broad-band radiation. Diffracted radiation is collected, measured, and recorded as a function of wavelength to provide an intensity versus wavelength curve. An initial model of the line profile of the grating, a model of the broad band radiation shined on the grating, and a model of the interaction of the radiation with the model grating is provided to a data processing machine. The machine uses Maxwell's equations to calculate a model diffracted intensity versus wavelength curve, and the measured intensity curve is then compared with this modeled intensity versus wavelength curve. The line profile in the model is then adjusted and the model intensity curve recalculated to improve agreement between the measured and calculated intensity curves. The model is repeatedly adjusted and the intensity recalculated until the best agreement between the two intensity versus wavelength curves is achieved. thereby providing the line profile. The method similarly provides composition profiles, such as doping depth profiles and optical coating profiles by taking advantage of the relationship between index of refraction and composition.